

Grand Canyon National Park and Grand Canyon Wildlands Council

**FALL 2003 REPORT
FOR
TAMARISK ERADICATION AND RESTORATION OF 63 TRIBUTARIES
IN
GRAND CANYON NATIONAL PARK**

Arizona Water Protection Fund Contract Number 99-075WPF

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Please Note: This report includes the same summary and background information as the Fall 2002 report, so that it can function as a stand-alone report for readers. This report, including Appendices A-D, is included on the compact disk that accompanies the report. The disk also contains all of the project photographs, organized into folders for each project area with each photograph dated.

I. Abstract

Tributaries and side canyons of the Colorado River, and seeps and springs in Grand Canyon National Park (GCNP), are among the most pristine watersheds and riparian habitat remaining in the coterminous United States. These riparian systems deserve a high level of protection from non-native plant invasion. The encroachment of tamarisk into these tributaries poses a significant threat to the integrity of the natural ecosystems. GCNP and the Grand Canyon Wildlands Council (GCWC) are committed to the preservation of native plant communities and native ecosystems. National Park Service (NPS) Management Policies require park managers “to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems” (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park’s resources (NPS 1985, NPS 2001b).

The primary objectives of this portion of the overall project are to remove tamarisk from 63 tributaries of the Colorado River in Grand Canyon National Park, and to monitor the success of the tamarisk removal through pre- and post-removal plant monitoring. This project will significantly reduce tamarisk distribution within the treated areas, and allow native vegetation to reestablish without exotic plant competition. Prior to initiation of the project, park staff completed extensive public scoping and prepared an Environmental Assessment / Assessment of Effect (EA/AEF). Under the Director’s Orders on Compliance (NPS 2001a), staff considered the cumulative effects of multiple projects, and included an analysis of tamarisk removal in all of the park’s tributaries. After review of the public comments, GCNP issued a Finding of No Significant Impact (FONSI) for the project in June 2002. Upon completion of the FONSI, GCNP restoration biologist Lori Makarick worked with the GCWC to revise the Tamarisk Eradication Plan, budget and contract for this project, and then began to plan the logistics for the fall 2002 river trips.

Project leaders and crew members conducted the first two eradication trips in the fall of 2002, and the second two eradication trips in the fall of 2003. GCNP staff, supported the NPS Exotic Plant Management Team (EPMT) based in Lake Mead National Recreation Area, completed one additional trip in March of 2003. Colorado River Fund monies supported the trip, and participants completed work in the 63 areas included in this AWPf funded project. During September 2003, volunteers manually removed seedlings in eight of the tributaries included in this AWPf funded project; the National Park Service’s Cooperative Conservation Initiative funded that work. With all of these trips combined, crews have removed over 56,000 tamarisk trees in 68 project areas. The 2003 AWPf funded trips were extremely successful, and this project (Phase I of the park’s overall tamarisk management project) is nearing completion. This report will summarize all of the work completed to date on this project, and will detail the remaining work that will be completed in the spring of 2004.

II. Introduction

a. Overview of project status.

The tamarisk eradication portion of this overall project within Grand Canyon National Park (GCNP) is nearing completion. The National Park Service (NPS) worked for two years to complete the first task listed in the above contract. The task was to “obtain all permits and environmental clearances necessary to conduct the proposed work.” The compliance process was longer than anticipated, due to new compliance guidelines, issued in 2001. The new guidelines, Director’s Order #12: Conservation Planning, Environmental Impact Analysis, and Decision Making, required that NPS complete public scoping and documentation prior to the initiation of this project (NPS 2001a). The documentation aims to ensure the use of interdisciplinary approaches and principles to decision-making, and that all decisions are based on technical and scientific information (NPS 2001a).

Public scoping and interdisciplinary team discussions about tamarisk management had been ongoing since 1998. The NPS issued the final Environmental Assessment / Assessment of Effect for the project to the public in February 2002. Staff received and analyzed public comments, and prepared a Finding of No Significant Impact Statement (FONSI), signed by the regional office on June 18, 2002. The park received a written response to the Informal Consultation with the U.S. Fish and Wildlife Service (USFWS) on January 25, 2001 and that letter, along with the incorporation of their recommended changes, completed the Section 7 consultation that was necessary for this project. On April 8, 2002, the State Historic Preservation Officer (SHPO) provided the park with written concurrence on the project moving forward.

By mid-June 2002, all of the necessary permits and clearances for this phase of the overall project were in hand. Project leaders revised the Tamarisk Eradication Plan to incorporate the new project timeline, which is as follows:

- October 2000 – 18-day river trip, transect installation and monitoring
- October 2002 – 18-day river trip, eradication trip #1
- November 2002 – 18-day river trip, eradication trip #2
- October 2003 – 18-day river trip, eradication trip #3
- November 2003 – 18-day river trip, eradication trip #4, and post-project monitoring and follow-up maintenance
- Spring 2004 – 18-day river trip, post-project monitoring and follow-up maintenance

At this time, this project is right on track and completion is near. Project leaders and crew members conducted the first two eradication trips in the fall of 2002, and the second two eradication trips in the fall of 2003. With the project initiated, the NPS received additional assistance for this project. GCNP staff, along with the NPS Exotic Plant Management Team (EPMT) based in Lake Mead National Recreation Area, completed one additional trip in March of 2003. Colorado River Fund monies supported the trip, and participants completed work in 14 of the 63 areas included in this AWPf funded project. During September 2003, volunteers manually removed seedlings in eight of

the tributaries included in this AWPf funded project; the National Park Service's Cooperative Conservation Initiative funded that work. The public and volunteers have also been supportive of this project, and the NPS is seeking additional funds to extend this project into the next phases.

The fall 2002 report included information about the first two eradication trips. This report combines that information with the 2003 results and provides a picture of the work completed to date. The 2003 AWPf funded trips were extremely successful, and this project (Phase I of the park's overall tamarisk management project) is nearing completion. This report will summarize all of the work completed to date on this project, and will detail the remaining work that will be completed in the spring of 2004.

b. Justification for recent work

Tamarisk (*Tamarix sp.*), commonly known as salt cedar, is an invasive, exotic shrub or tree that grows in dense stands along rivers and streams in the West. Tamarisk, introduced to the U.S. in the 19th century as an erosion control agent, spread through the West and caused major changes to natural environments. Tamarisk reached the greater Grand Canyon area during the late 1920s and early 1930s, and became a dominant riparian zone species along the Colorado River following completion of Glen Canyon Dam in 1963. The impacts caused by tamarisk in the Southwest are well documented (refer to Reference Section of the EA/AEF and Stevens 2001). These prolific nonnative shrubs displace native vegetation and animals, create conditions that are inhospitable for the germination of native plant seeds, and increase fire frequency. Salt cedar is an aggressive competitor, often developing monoculture stands and altering water tables, which can negatively affect wildlife and native vegetative communities (Duncan 1996). In many areas, tamarisk occupies previously open spaces and is adapted to a wide range of environmental conditions. Once established in an area, it typically spreads and persists.

Distinctive soil types, vegetation, and hydrologic conditions characterize riparian areas that provide biologically diverse and productive ecosystems. In the Southwest, riparian areas account for less than 2% of the land, yet over 65% of Southwestern wildlife depend on riparian habitats. Riparian habitats are the most productive, most valuable and most threatened habitats in the American Southwest (Johnson et al. 1985). Tributaries and side canyons of the Colorado River, and seeps and springs in GCNP, are among the most pristine watersheds and desert riparian habitat remaining in the coterminous United States. These riparian systems deserve a high level of protection from non-native plant invasion. The recent encroachment of tamarisk into these tributaries poses a significant threat to the integrity of the natural ecosystems. GCNP is committed to the preservation of native plant communities and native ecosystems (NPS 1995a, NPS 1995b). NPS management policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park's resources (NPS 1985, NPS 2001b). The removal of tamarisk from these tributaries will provide this protection, and allow native plant communities to recover, with an expected increase in native plant species following tamarisk removal.

III. Methods

a. Area of interest in recent analysis

Under this contract, crews will remove tamarisk from 63 areas within Grand Canyon National Park, selected based on the numbers of tamarisk trees found during the preliminary surveys (i.e. feasibility of control at this time) and the extent of the seeps, springs, and riparian habitat found within the project areas.

High species diversity, high species density, and high productivity generally characterize riparian areas. Continuous interactions occur among riparian, aquatic, and upland terrestrial ecosystems through exchanges of energy, nutrients, and species. Warren et. al. (1982) provided the following description:

“Riparian woodlands (or forests) characterized by cottonwood-willow associations are primarily restricted to the larger perennial streams and drainages of the Colorado Plateau region of northern Arizona. The great biological importance and floristic diversity of these cottonwood-willow riparian forests is disproportionate to their limited total area.... Riparian scrub usually occurs along ephemeral or intermittent watercourses (such as desert arroyos), or in narrow canyons which are periodically scoured by floods. Riparian scrub communities are characterized by a broad continuum of vegetative associations that range from mesic vegetation types to xeric growth along desert arroyos (Brown et al., 1980). These arroyos often contain water only one day or less each year and the resulting vegetation is commonly composed of a mixture of facultative riparian species and upland species. This is in contrast to mesic species, which are generally absent from the surrounding uplands.... Side canyons throughout the park with perennial water support riparian vegetation characterized by cottonwood (*Populus fremontii*) and willow (*Salix* spp.) which is generally very similar to that found in similar situations throughout northern Arizona (Phillips and Phillips, 1979)....”

Each dry wash, spring, seep, or stream has a different association of species, depending on environmental features including elevation, permanence of water, substrate, frequency of flooding, and colonization (Warren et al., 1982). Riparian vegetation typically occurs in small, discrete stands or patches. The floristic diversity in wetland and riparian composition is highly variable, but is extremely high when compared to the upland vegetation. Typical stands may consist of broad-leaved deciduous trees in the overstory, with a mixture of shrubs and grasses in the understory. Species typical of drainages with perennial water sources are:

- | | |
|---|---|
| ♣ Fremont cottonwood (<i>Populus fremontii</i>) | ♣ Willow (<i>Salix exigua</i> , <i>Salix goodingii</i>) |
| ♣ Brickellia (<i>Brickellia longifolia</i>) | ♣ Monkey flower (<i>Mimulus cardinalis</i>) |
| ♣ Catclaw acacia (<i>Acacia gregii</i>) | ♣ Mesquite (<i>Prosopis glandulosa</i>) |
| ♣ Apache plume (<i>Fallugia paradoxa</i>) | ♣ Emory baccharis (<i>Baccharis emoryi</i>) |

Species typical of drainages with dry washes or intermittent water are:

- | | |
|--|--|
| ♣ Catclaw acacia (<i>Acacia greggii</i>) | ♣ Mormon tea (<i>Ephedra</i> spp.) |
| ♣ Baccharis (<i>Baccharis</i> spp.) | ♣ Four-wing saltbush (<i>Atriplex canescens</i>) |
| ♣ Snakeweed (<i>Gutierrezia sarothrae</i>) | ♣ Fremont cottonwood (<i>Populus fremontii</i>) |
| ♣ Apache plume (<i>Fallugia paradoxa</i>) | ♣ Skunkbush (<i>Rhus trilobata</i>) |
| ♣ Utah agave (<i>Agave utahensis</i>) | ❖ Red-bud (<i>Cercis occidentalis</i>) |

Upland species, described below, are also present in these dry or intermittent washes. Trees and shrubs tend to be scattered, but may also form dense thickets. Species composition varies depending on moisture availability, elevation, and geographic location in the canyon. Within the park, tamarisk occurs in the many of the side canyon and tributaries; however, the distribution and density is highly variable.

The vegetation surrounding the tributaries is generally from desert scrub communities, which are composed of plant species from three of the four North American desert floras. The Sonoran desert scrub has the highest diversity of species. A two-season rainfall regime and lack of freezing temperatures characterizes the Sonoran desert (Warren, et al. 1982). The Mojave desert scrub has higher local species diversity, but is primarily dominated by shrubs; it is characterized by winter rains and the absence of freezing temperatures (Warren, et al. 1982). The Great Basin desert receives more winter rain than the Mojave, and frequently has severe winter freezes and the lowest diversity of the three (Warren, et al. 1982).

Big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* spp.), Mormon tea (*Ephedra* spp.) and a variety of perennial grasses dominate the Great Basin desert scrub. These associations are typically found in the lower portion of the canyon and comprise the vegetation surrounding some of the middle and lower tributaries. Typical Mojave desert species include blackbrush (*Coleogyne ramosissima*), turpentine broom (*Thamnosma montana*), bladder sage (*Salazaria mexicana*), and other species. The Sonoran desert species include brittle bush (*Encelia farinosa*), catclaw acacia (*Acacia greggii*), ocotillo (*Fouquieria splendens*) and desert willow (*Chilopsis linearis*). Sonoran associations occur in the lower portion of the canyons, and many of these species can grow directly in infrequently scoured drainages.

Please refer to the next sections for the complete list of areas in which work crews completed work under this project.

b. Dates, times and conditions under which work was completed

Crews completed the tamarisk eradication work was completed in October and November 2002 and 2003; trees are still actively transporting nutrients and water through the phloem and xylem during these months, and the insertion of herbicide into the tree yields effective control results. Crews completed one additional trip in March 2003, and the work provided good results.

On each trip, the workdays were long, with coffee served between 6:00 and 6:30 a.m., and dinner often not ready until long after dark, yet once again, the participants enjoyed the project. Due to the remoteness of the terrain, it is necessary to access the majority of the project areas from the river. Each of the fall trips launched from Lees Ferry and took out at Diamond Creek. On each of the fall trips, there were 16 participants and 5 rafts, and on the March 2003 trip, there were 18 participants (including two archeologists) and 6 rafts. On each trip, there was an exchange at Phantom Ranch, and new, invigorated volunteers arrived to assist with the project while the upper half volunteers told horror stories about the long days and blisters. The dedication and perseverance of all of the crew members was amazing and contributed to the overall success of the project. The volunteers were crucial to the project accomplishments. Volunteers donated 1620 hours in October 2003 and 959 in November 2003. The total hours spent on the two fall 2003 trips was 6149; therefore, volunteers supplied about 42% of the total hours in 2003. Please refer to Appendix D for complete project hour data for 2003.

Table 1. October 2003 Participant List

Trip Coordinator / Project Leader	Lori Makarick	Lori Makarick
Head Boatman / Trip Leader	Jeri Ledbetter	Jeri Ledbetter
Boatman	Larry Stevens	Larry Stevens
Boatman	Alison Steen	Matt Dunn
Boatman	Kim Crumbo	Kim Crumbo
Boatman	Chris Louderback	Kate Thompson
Volunteer Safety Kayaker	Matt Dunn	John Sterling (not kayaking)
Crew Leader #1	Kate Watters	Kate Watters
Crew Leader #2	Kim Fawcett	Kim Fawcett
Volunteer / Crew Leader #3	Johanna Divine	Anne Hadley
Cook / Worker	Simone Sellin	Simone Sellin
Volunteer	Jessica Cortright	Jessica Cortright
Volunteer	Scott Smith	Scott Smith
Volunteer	Heather Millar	Herman Griego
Volunteer	Kelly Watters	Kelly Burke
Volunteer	Dave Gentempo	Margie Erhart

Table 2. November 2003 Participant List

The project participants on the November 2003 trip were:

Role	Upper Half	Lower Half
Trip Coordinator / Project Leader	EMPTY – DO NOT FILL	Lori Makarick
Head Boatman / Trip Leader	Dan Hall	Dan Hall
Boatman	Chris Louderback	Chris Louderback
Boatman	Alison Steen	Alison Steen
Boatman	Nicole Corbo	Nicole Corbo
Boatman	Michael Whalen	Rachel Schmidt
Volunteer	EMPTY – DO NOT FILL	Dave Gentempo
Crew Leader #1	EMPTY – DO NOT FILL	Kate Watters
Crew Leader #2	EMPTY – DO NOT FILL	Kim Fawcett
Crew Leader #3	EMPTY – DO NOT FILL	Angela Sokolowski
Cook / Worker	EMPTY – DO NOT FILL	Simone Sellin
NPS Rep / Volunteer	Chad Olson	Willow Nelson
Volunteer	EMPTY – DO NOT FILL	Chris Moore
Volunteer	EMPTY – DO NOT FILL	Steven Till
Volunteer	EMPTY – DO NOT FILL	Jessica Cortright
Volunteer	EMPTY – DO NOT FILL	Beach Huntsman

The project leader prepared itineraries, reviewed and approved by park management, prior to each trip (please refer to Table 1 and Table 2 for the final itineraries for the trips). Poor weather conditions and additional time needed at specific sites necessitated alteration of the itinerary on several occasions. During all trips to date, there were a few days of rain. Many of the project areas are in narrow side canyons, which are subject to flash flooding. On rainy days, crews only worked in wide open canyons that would be safe during a flood event. On those days, crews did not use the cut stump method since the rain could cause herbicide runoff. The weather on the October 2003 trip was remarkable, with rain only on the first day, causing the crews to pass by Soap Creek to make time on the river. During the November 2003 trip, the boatmen rowed the rafts down to Phantom empty since the project areas were all on the lower half of the river. The NPS provided a wildlife biologist for the upper half of the trip (as the NPS representative), and he was able to get raptor surveys completed during the 4 days of transit. The boatmen arrived on time, but regaled us with stories of the windiest river days they had ever seen. Two of the boatmen had blisters on their hands that were wide open and raw, yet, to these dedicated folks sawed tamarisk trees the next day.

Table 3. October 2002 Itinerary

Grand Canyon National Park / Grand Canyon Wildlands Council
Tamarisk Eradication Trip #3
October 3-20, 2003

DAY	DATE	CAMP	RM	PROJECTS
Wednesday	10/1			Food purchase/pack and get boats loaded. Jeri/Matt will pack river equipment, Lori/Kim will pack tools/herbicide & deliver to Larry's, Simone/Jessica will be responsible for shopping and food.
Thursday	10/2	Lees Ferry – We'll do dinner at VC or MC.		RIGGING DAY! Meet at 9am at Larry's house on N. San Francisco. Once at Lees Ferry – rig the boats, have lunch, and spend afternoon with project briefing.
Friday, Day 1	10/3	Hot Na-Na area	16.4 L	All people going downstream need to be at Lees Ferry by 7:30am for an 8:30am departure!!! Really. We will stop at Soap and re-treat the trees there (just to the boundary).
Saturday, Day 2	10/4	Buckfarm Canyon	41 R	North Canyon (Team 1)
				First Redbud alcove (Team 2)
				Second Redbud alcove (Team 2)
				Tatahatso Wash (Team 2)
Sunday, Day 3	10/5	Kwagunt	56.2 R	Buckfarm (Team 1)
				Bert's Canyon (Team 2)
Monday, Day 4	10/6	Kwagunt	56.2 R	Kwagunt
Tuesday, Day 5	10/7	Carbon	64.7 R	Carbon Canyon - just to narrows
Wednesday, Day 6	10/8	Lava Chuar	65.5 R	Lava Chuar
Thursday, Day 7	10/9	Lava Chuar	65.5 R	More Lava Chuar
Friday, Day 8	10/10	Nevills	75.6 L	Basalt (Note - we'll have to prioritize today.....)
				74 Mile Wash (Team 1)
				Escalante (Team 1)
				75 mile canyon (Team 2)
Saturday, Day 9	10/11	Cremation	87.2 L	Vishnu (Team 1)
				85 Mile Spring (Team 2)
				Clear Creek (Team 2)
Sunday, Day 10	10/12	Schist	96 L	EXCHANGE DAY!!! Let's pick up the new folks and be heading downstream by 11am. No work today - but orientation to the project for new folks, clean up coolers, organize tools, etc.
Monday, Day 11	10/13	Slash/Parkins Camp	108 L	Boucher (Team 1)
				Tuna Creek (99 R) (Team 2)
Tuesday, Day 12	10/14	Bighorn Wash	117 L	Hakatai 111 R
				Bighorn Wash (re-check if time)
Wednesday, Day 13	10/15	Galloway	131.8 R	Specter 129 L (Team 1)
				Galloway (Team 2)
Thursday, Day 14	10/16	Fishtail	139 R	Cranberry (Team 1)
				Fishtail, camp (Team 2)
Friday, Day 15	10/17	Tuckup	164.5 R	Tuckup
Saturday, Day 16	10/18	Parashant	198.5 R	Transit Day
Sunday, Day 17	10/19	222 Mile	222 R	Transit Day - See where others are camping, go low down. Start cleaning up supplies, coolers, etc.
Monday, Day 18	10/20	Sus casitas		TAKE OUT!!! Wakey wakey!!!

Table 4. November 2002 Itinerary

Grand Canyon National Park / Grand Canyon Wildlands Council
Tamarisk Eradication Trip #4
October 29 - November 15, 2003

DAY	DATE	CAMP	RM	PROJECTS
Monday	10/27			Food purchase/pack and get boats loaded. Dan will be responsible for packing equipment, Simone/Kim will be responsible for shopping and packing all food.
Tuesday	10/28	Lees Ferry – Dinner in the big town on the range		RIGGING DAY! Meet at 9am at Can-ex. Drive to Lees Ferry – rig the boats.. The upper portion of this trip will be dedicated to transit, so it will just be boatmen, 1 NPS representative.
Wednesday, Day 1	10/29	Lone Cedar	23.7 L	Transit Day
Thursday, Day 2	10/30	Eminence	44	Transit Day
Friday, Day 3	10/31	Carbon	64.5 R	Transit Day
Saturday, Day 4	11/1	Cremation	87.1 L	*Folks hiking in will arrive today by 3pm at Roy's Beach - boatmen - shuttle over to get 'em, we'll do a 4pm briefing/dinner/orientation. People can go over to Phantom after that for phone calls, etc. - but we will not have access to the bunkhouse or other facilities. Note- Hikers meet at 411 S. Taber in Williams at 9:30 for ride to South Rim.
Sunday, Day 5	11/2	Granite	93.4 L	Trinity (Team 1)
				Salt (Team 1)
				Monument (everyone else)
Monday, Day 6	11/3	94 Mile	94.3 R	94 Mile Creek
Tuesday, Day 7	11/4	Slash/Parkin's	108	Ruby
				Serpentine
Wednesday, Day 8	11/5	Bighorn Wash	117 L	Hotauta
				Garnet
				Bighorn Wash - if time
Thursday, Day 9	11/6	Forster	122.7 L	Blacktail (Team 1)
				122 Mile (Team 2)
				Forster (Team 2)
Friday, Day 10	11/7	Stone	132 R	Fossil (Team 1)
				128 Mile (Team 1)
				Bedrock (Team 2)
Saturday, Day 11	11/8	Stone	132 R	Stone Creek
Sunday, Day 12	11/9	Kanab Area	143	133 Mile Creek
				142 Mile Spring
Monday, Day 13	11/10	Ledges	151 R	148 Spring
				Matkatamiba
Tuesday, Day 14	11/11	Last Chance	155.7 R	152 Springs
				Slimey Tick
				Last Chance
Wednesday, Day 15	11/12	Cove	174 R	Fern Glen
				Cove
Thursday, Day 16	11/13	202 Mile	202 R	Transit Day - Photodoc if time
Friday, Day 17	11/14	223 Mile	223 L	Transit Day and Clean Coolers and Tools, etc.
Saturday	11/15	YER HOMEYS		Wakey wakey eggs and bay-key!

c. Tamarisk control methods and conditions

Each fall river trip was 18 days long and consisted of 16 people, although the March 2003 trip had 18 people. The trip length allowed for sufficient time to access and work in canyons on the itinerary. The goal of the control work was to target 15 tributaries per trip, totally the 63 canyons over the 4 control trips during the project period. The October 2003 trip focused on canyons along the upper half of the river (Lees Ferry to Phantom Ranch) and the November 2003 trip focused on canyons along the lower half of the river, and participants hiked in to this trip at Phantom Ranch. Some project areas required repeated visits to complete the initial control of the entire tamarisk populations, and some of these areas still require additional work on the upcoming March 2004 trip (funded by the Grand Canyon National Park Foundation).

After incorporation of public comments into the Environmental Assessment / Assessment of Effect (EA/AEF) document, which is required under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA), project managers selected the final control methods. For this project, staff use a combination of methods including mechanical, chemical, and cultural (i.e. seeding). The restoration biologist / project leader selected the methods for each project location based on site characteristics and weather conditions; a brief description of each method follows:

Manual Removal

This is the method used for seedlings (and sometimes larger trees) in washes, streambeds, and non-sensitive areas. Hand tools (i.e. picks, pulaskis, and shovels) are used to loosen the soil surrounding the larger plants and then the entire root system, or at least below the root crown, is removed.

Garlon Lance Injection

The lance injector is a three- to four-foot long tool with four chambers. Small herbicide capsules (approximately $\frac{3}{4}$ " long by $\frac{1}{4}$ " in diameter) are placed inside the chambers, the lance is placed against the trunk of the tree, and as the top of the lance is pushed, the chamber opens and a capsule is inserted into the tree. The trunk's diameter determines the number of capsules inserted.

Girdle Method (a.k.a. Hack and Squirt)

With this method, crews use a hatchet, tree girdler, or hand saw to cut downward into the water-conducting tissue (phloem) of standing trees then apply the herbicide mixture directly into the cut with a hand-pressurized sprayer (and coarse spray nozzle). On larger trees, two or more cuts are necessary.

Cut Stump Method

Crews cut the tree trunks near ground level with handsaws and then spray with Garlon4 mixed with a penetrating oil (JLB oil) at a rate of 25% herbicide to 75% oil. The tree's phloem absorbs the mixture and transports it to the roots, with quick application increasing the effectiveness. Pressurized hand sprayers allow precision herbicide application with minimum overspray or drift risk. Crews now extensively use this method along, and in combination with girdling, since the control results have been high.

Basal Bark Application

With this method, crews treat the entire stem with Garlon4 (same mixture as above) from near ground level up several inches. Crews apply the chemical with hand held pressurized sprayers, which have small nozzles with coarse spray settings that allow for direct spraying with minimal drift or overspray. This method is much less labor intensive, but is less effective on mature trees so limited use on smaller saplings and seedlings occurs.

Mitigation Measures

The following specific measures apply to all methods used for the project:

- Debris is disposed of to minimize visual impact (i.e. off trail, out of the drainage).
- Empty herbicide capsules are removed from trees in the year following treatment.
- Cut stumps are hidden from view to the extent possible.
- Soil is tamped where manual removal is used to help minimize establishment of other invasive exotic species and to minimize visual impact.
- Tree cuts are made on tree sides least visible to backcountry users.
- When pruning, a minimal number of branches are cut to minimize visual impact.

Much of the debris remains on site to decompose and provide habitat for wildlife. Crews minimize the visual impacts of the project through carefully placed cuts and girdles and the combination of control methods employed at each project site.

Herbicide Use

The herbicide used for control was Garlon4 (triclopyr based), which is a general use herbicide, in a mixture of 25% Garlon4 and 75% JLB oil. Stainless steel sprayers, pressurized with bicycle pumps, are the application tool.

Pesticide certification is not required for Garlon application; however, the park vegetation staff adopted the policy of having trained and certified application on site during application. During these trips, the project leader, all field crew leaders, and some of the volunteers had Arizona State pesticide certification. All project participants received herbicide orientation and training from the project leader. Project participants understood and abided by the established Personal Protective Equipment (PPE) requirements and rules outlined in the safety plan for the project. Rubber gloves, long sleeve shirts, long pants, and eye protection were part of the PPE necessary for this project. All project participants reviewed the job hazard analyses (JHAs) for exotic plant removal and herbicide application.

Project participants followed all information and instructions on the herbicide label. All herbicide containers were leak- and spill resistant. All application equipment and chemicals were stored in sealed ammunition cans or large silver boxes during transport on rafts, and all storage containers had the product's specimen label and the Material Safety Data Sheet (MSDS) clearly displayed underneath a waterproof plastic sheet. The MSDS contains fire and explosive hazard data, environmental and disposal information, health hazard data, handling precautions, and first aid information. All trip participants reviewed the MSDS with the project leader and understood the first aid instructions described on the MSDS. One boat contained all herbicide and application

equipment, herbicide containers, and PPE disposal containers, isolated from food and personal items.

d. Analysis of methods and tests

Although current scientific literature documents successful control methods for tamarisk, refinement to the methods occurred during the work in Grand Canyon. Please refer to Appendix A for examples of methods and sample photographs, and to the fall 2002 report for preliminary discussion of methods.

Crews used the Garlon lance injection method in 2002. Some benefits are that it is safer for the applicators, since there is less likelihood of contact with herbicide, and rainy conditions do not preclude the use of this method. When crews revisited Clear Creek in March 2003, the injected trees were still alive. Crews removed the capsules, and cut the trees. During 2003, 75 mile canyon flash flooded hard, and during the fall revisit, some of the injected trees were not locatable and likely had washed down the canyon. This was a significant concern since crews could not retrieve the empty capsules. Overall, crews found that the control effectiveness was low with this method and did not use it in 2003. However, park staff will further test this method in a controlled and easily visited setting and make a final determination about future use.

Crews used the hack and squirt method in 2002, but based on the control results and input from the Lake Mead EPMT on the March 2003 trip, project leaders altered the technique prior to 2003 and renamed it the girdle methods. Crews determined that it is necessary to cut into the outer bark (about ½” deep) all the way around the tree trunk, leaving no section uncut. The cut can be lower to the ground than initially planned. Another key to the success is but to also spray the tree trunk from the cut to the ground in addition to application into the cut. Crews still use this method on scattered individual trees, but it remains difficult to use as the sole method in dense stands.

Crews now extensively use the cut stump method alone, and in combination with girdling, since the control results have been the highest. It is also easiest to retreat those areas. Crews did notice that on previously cut mature trees, the regrowth tended to be a basal cluster affectionately named an “afro”. The retreatment method for the afros was basal application and no additional cutting was necessary.

IV. Results

a. Results of recent data collection

During the fall 2003 river trips, crews controlled 19572 tamarisk trees including 12596 seedlings, 4854 saplings, and 2122 mature trees (Refer to Figure 1). The total tamarisk canopy cover removed from the project sites was 9991 square meters. During the March 2003 river trip, crews completed work in 14 project areas, removing 10800 tamarisk trees including 6549 seedlings, 3008 saplings and 1243 mature trees for a total canopy cover of 8868 sq. meters.

On each trip and at each project site, the project leader analyzed the site and determined which control methods to use. Refer to Table 3 for complete control data for all of the project areas to date. Figure 2 summarized the methods used on all of the tamarisk control trips combined.

The amount of herbicide used, a mixture of 75% JLB Oil to 25% Garlon 4, was surprisingly low during 2003. A total of 42.5 mixed gallons were used on the March, October and November 2003 trips; this is equivalent to 10.62 gallons of Garlon4 concentrate and 31.97 gallons of JLB Oil.

Crews completed at 68 project areas (Monument Spring, Salt Creek Spring, and Ledges Spring are listed as separate sites in the data), a few of which are not on the AWPf list and were done in addition to the 63 on the list. These are Upper Redbud, Saddle Canyon, 91 Mile Canyon (R), 105 Mile Canyon (R), and Mohawk Canyon.

Crews completed follow-up control work in many areas, yet in several areas, the work required much more labor than predicted. The following sites, due to extensive populations, weather, or lack of time, will require additional visits and control implementation, scheduled for March 2004:

- 2nd Redbud Alcove (quick re-check)
- Kwagunt Creek
- Carbon Creek
- 75 Mile Creek (quick re-check)
- Monument Creek
- 94 Mile Creek (1 small patch remains)
- Boucher Creek
- Tuna Creek
- Fossil Canyon
- 128 Mile Creek
- Bedrock Canyon
- 142 Mile Springs
- 148 Mile Springs
- Stairway Canyon
- Cove Canyon

Work has not yet begun at the following project sites:

- Lower Bright Angel Creek
- Pipe Creek
- Hermit Creek
- South Bass Canyon
- 133 Mile Creek
- 150 Mile Canyon

We anticipate that crews will initiate work in these sites in February 2004. The 133 Mile Creek and 150 Mile Canyon sites are only accessible from the river and are included in the itinerary for March

2004 Colorado River Fund trip. Crews will access the other areas listed above, and Mounment Creek, by hiking.

A large component of this project is the long-term monitoring, included with the control work. On the first river trip (October 2000), participants installed the majority of the monitoring components. The components include vegetation transects and photopoints. On the fall 2002 and 2003 trips, crews installed photopoints in additional project areas. Please refer to the monitoring plan for the overall design and implementation scheme. Appendix B contains representative samples of the photodocumentation and Appendix C includes the summary data for all installed photopoints for the project. The compact disk included with this report also contains all of the photographs taken for this project to date, organized by project area and date taken. The disk also included photographs of the crews working and examples of the various techniques used.

b. Graphs, charts and tables pertaining to results

Table 5 Tamarisk Control Summary

Canyon Name	Pulled	Inject	Combo Cut / Girdle	Girdled	Basal Bark	Cut Stump	Cover m2	Seedling	Sapling	Mature	Total
105 Mile Canyon R	0	0	0	0	0	17	40	0	9	8	17
122 Mile Creek R	2	0	0	10	0	3	15	0	3	12	15
128 Mile Creek R	227	0	0	0	0	62	98	226	24	39	289
142 Mile Spring	0	0	0	2	0	12	103	0	5	9	14
148 Spring (Above Matkatamiba R)	0	0	5	1	0	21	88	0	17	10	27
152 Springs R	10	0	0	0	0	72	31	13	52	17	82
1st Redbud Alcove	0	0	0	0	0	49	62	16	27	6	49
209 Mile Canyon R	8	0	0	0	5	155	393	9	109	50	168
214 Mile Creek	3	0	0	0	0	40	62	1	32	10	43
2nd Redbud Alcove	0	0	0	1	0	10	29	1	6	4	11
75 Mile Creek	261	31	0	0	0	4	74	267	23	6	296
85 Mile Spring	7	0	0	0	0	40	19	12	30	5	47
91 Mile Canyon R	0	0	0	0	0	42	125	0	26	16	42
94 Mile Canyon	50	7	0	0	0	563	830	39	397	184	620
Basalt Canyon	4096	0	0	13	0	105	452	4093	57	64	4214
Bedrock Canyon	89	0	0	0	0	190	348	101	98	80	279
Bert's Canyon	0	0	0	1	0	14	16	4	4	7	15
Bessie's Camp Creek	0	0	0	15	0	13	127	1	9	18	28
Bighorn Wash	193	0	0	52	0	52	194	223	40	34	297
Blacktail Canyon - Upper	202	0	1	0	0	239	219	148	267	27	442
Boucher Creek	5024	0	36	99	122	3510	2316	6773	1423	595	8791
Buckfarm Canyon	3	0	0	0	0	51	102	11	21	22	54
Carbon Creek	0	0	0	12	0	133	602	5	31	109	145
Clear Creek	616	36	0	2	23	171	246	711	114	23	848
Cove Canyon - Lower	33	19	0	192	0	186	853	7	214	209	430

Canyon Name	Pulled	Inject	Combo Cut / Girdle	Girdled	Basal Bark	Cut Stump	Cover m2	Seedling	Sapling	Mature	Total
Cove Canyon - Upper	420	0	2	4	0	6	117	418	5	9	432
Cranberry Canyon	0	0	0	0	0	28	26	0	21	7	28
Elves Canyon	147	0	0	0	0	49	287	148	18	30	196
Escalante Creek	0	0	0	20	0	1	52	0	6	15	21
Fern Glen Canyon	0	0	0	0	0	2	2	0	1	1	2
Fishtail Canyon	0	0	2	2	0	5	35	0	5	4	9
Forster Canyon	26	0	1	0	0	186	282	22	136	55	213
Fossil Canyon	23	0	0	0	0	0	5	21	2	0	23
Galloway Canyon	343	0	2	0	0	1150	1582	641	462	392	1495
Garnet Canyon	180	0	0	4	0	287	317	194	194	83	471
Hakatai Canyon	8	0	0	0	0	83	118	8	54	29	91
Hotauta Canyon	3	0	0	0	0	72	67	6	39	30	75
Kwagunt Creek	467	43	12	71	145	2557	2234	1681	1278	336	3295
Last Chance Spring	151	0	0	0	0	92	46	162	74	7	243
Lava Chuar	66	0	59	33	174	2432	5068	447	1656	661	2764
Ledges Spring	162	0	1	14	0	45	132	149	53	20	222
Lonetree Canyon	53	0	0	14	0	214	233	146	109	26	281
Malgosa Canyon	0	0	0	30	0	12	246	2	7	33	42
Matkatamiba Canyon	926	0	5	1	0	21	200	926	17	10	953
Mohawk Canyon	6824	0	0	0	0	0	750	6824	0	0	6824
Monument Creek	7856	0	0	0	114	2004	2748	9016	697	261	9974
Monument Spring	50	0	0	0	0	0	10	50	0	0	50
North Canyon	14	0	0	32	0	30	209	26	8	42	76
Palisades Creek	0	0	0	0	0	20	59	3	2	15	20
Rider Canyon	184	0	0	1	2	77	131	231	25	8	264
Ruby Canyon	0	0	0	0	0	9	0	0	1	8	9
Saddle Canyon	21	0	0	0	0	46	48	0	67	0	67

Canyon Name	Pulled	Inject	Combo Cut / Girdle	Girdled	Basal Bark	Cut Stump	Cover m2	Seedling	Sapling	Mature	Total
Salt Creek	15	0	0	0	0	27	22	34	5	3	42
Salt Creek Spring	20	0	0	0	0	0	5	20	0	0	20
Serpentine Canyon	2	0	0	0	0	102	110	2	57	45	104
Shinumo Creek	66	0	0	3	31	55	16	110	29	16	155
Slimey Tick Canyon	2031	0	0	0	0	92	103	1919	188	16	2123
Soap Creek	0	0	0	0	3	22	48	3	0	22	25
Specter Chasm	7	0	0	0	0	70	118	8	35	34	77
Stairway Canyon	2	0	1	0	0	57	136	6	34	20	60
Stone Creek	4289	0	0	0	103	2134	1277	5467	1035	24	6526
Tatahatso Wash	0	0	0	2	0	8	32	4	4	2	10
Trinity Creek	44	0	0	0	0	301	261	137	161	47	345
Tuckup Canyon	839	0	0	0	0	5	5	807	33	4	844
Tuna Creek	17	0	5	0	4	245	385	68	162	41	271
Upper Redbud	9	0	0	0	0	31	116	9	2	29	40
Vishnu Creek	16	0	0	40	0	196	467	92	72	88	252
Waltenberg Canyon	12	0	0	0	0	8	11	9	5	6	20

As of December 2003:

Total Tamarisk Trees Removed: 56317

Actual Tamarisk Cover Removed: 25560

Figure 1. Tamarisk Control by Size

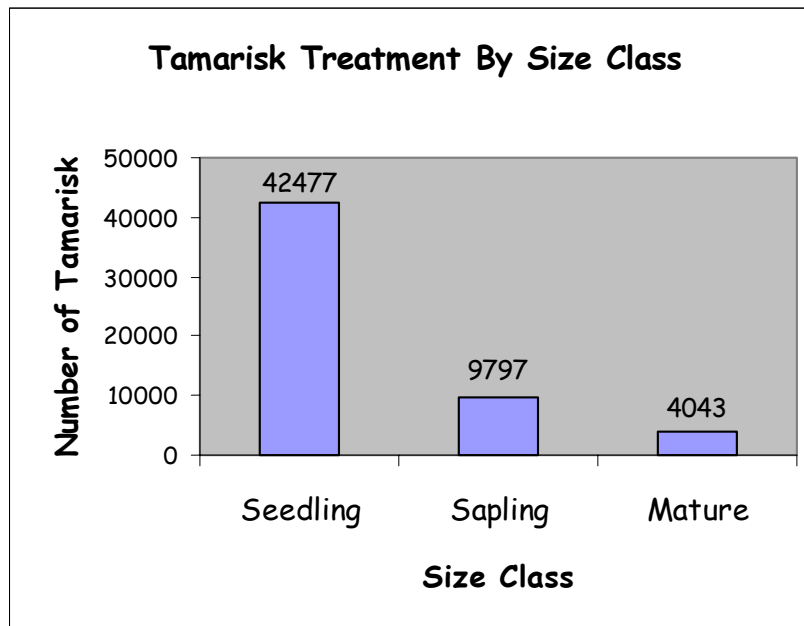


Figure 2. Tamarisk Control by Method

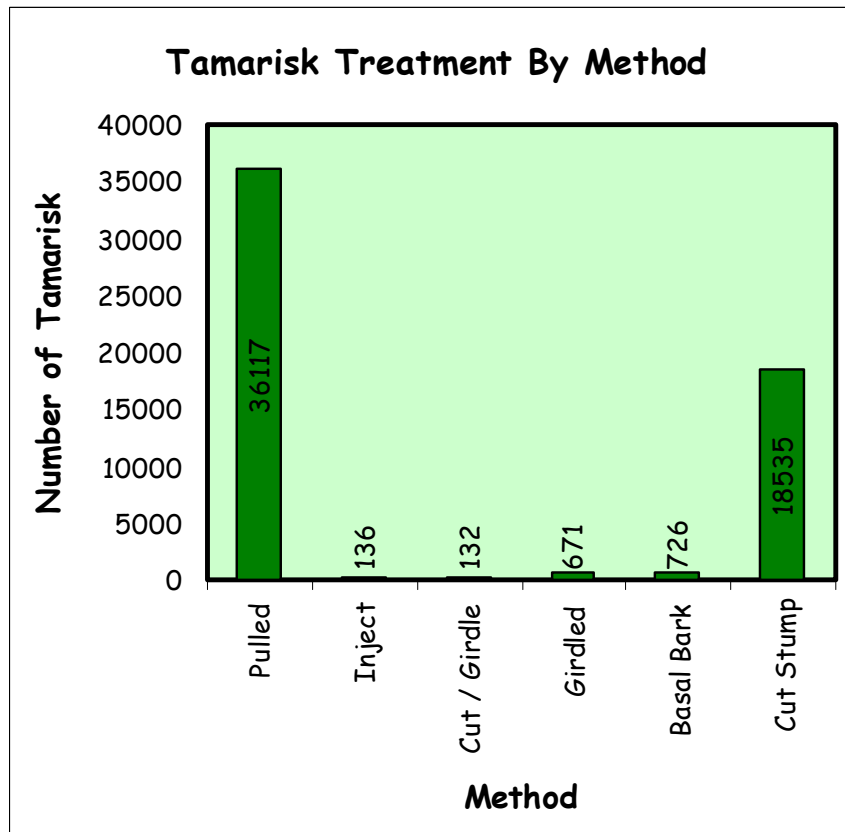


Figure 3. Tamarisk Retreatment to Date – Numbers by Size Class

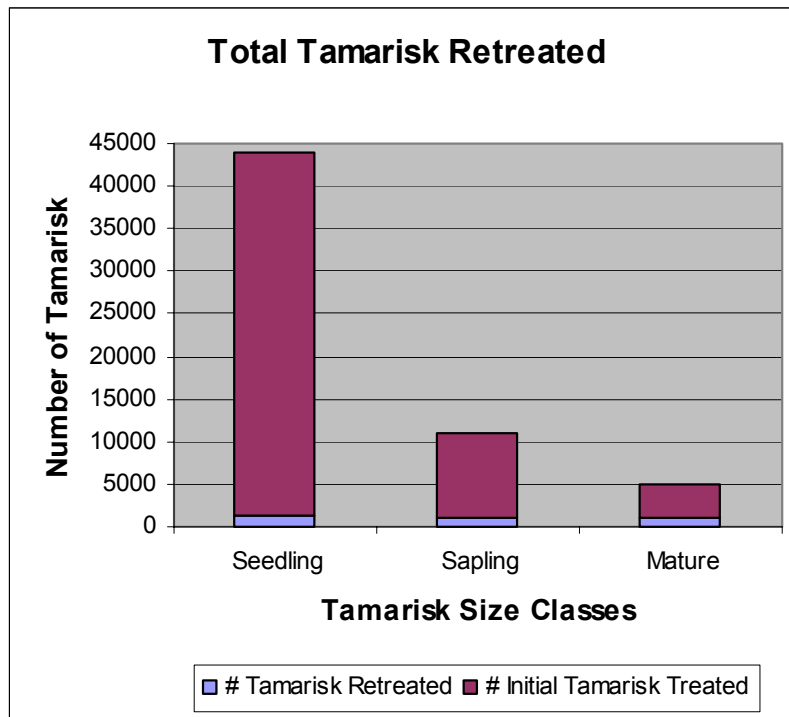


Table 6 Tamarisk Retreatment to Date – Percentage by Size Class

Size Class	# Tamarisk Retreated	# Initial Tamarisk Treated	% Retreated
Seedling	1376	42477	3.24
Sapling	1168	9797	11.92
Mature	1019	4043	25.20
Total	3563	56317	6.33

V. Discussion and Conclusions

a. Discussions and conclusions about results comparing current, and past control results

After working with the professional EPMT crew from Lake Mead, project crews realized that they were applying an insufficient amount of herbicide to the cut stumps, and increased the amount used. This explains some of the high rates of retreatment necessary in 2003. Overall, crews have only retreated 6.33% of the total number of tamarisk initially treated (refer to Figure 3 and Table 4). However, upon removal of the large seedling component from the data summaries, 11.9% of the saplings and 25.2% of the mature trees controlled in 2002 were retreated in 2003. Project leaders feel that project success rates will be much higher in the future with the implemented changes. The final monitoring trip will be from May 26 through June 14, 2004; the subsequent final report for this project will contain control conclusions and discussion.

b. Discussion and conclusions about results with relation to related literature.

This report contains the control data from the control trips to date and information about preliminary project results. The final monitoring trip will be from May 26 through June 14, 2004; the subsequent final report for this project will contain control conclusions and discussion.

VI. Management Recommendations

a. Overview of management options.

During the implementation of this project, crews implemented tamarisk control methods in 68 areas within GCNP. The monitoring results of this project will help further refine the control methods and management options. The National Park Service has an affirmative responsibility to protect and preserve the resources located within its units. National Park Service (NPS) Management Policies require park managers “to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems” (NPS 2001b). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park’s resources (NPS 1985, NPS 2001b).

This project has verified that the control of tamarisk in the park’s side canyons and tributaries is indeed feasible. A vast body of literature documents the impacts that tamarisk has on southwestern ecosystems, and Stevens (2001) summarized the impacts and ecology of the species. Since the control is feasible and tamarisk posed a substantial impact on the resources located within GCNP, the continuation of this project to include the other phases should occur. Park management have

been supportive of this project, and with continued documentation and successful implementation, the support should remain strong.

b. Management recommendations and justification.

The EA/AEF for this overall project included three phases of tamarisk management and tributary restoration. The work completed under this contract is Phase I of the overall project. The first five control trips were very successful and crews worked out the overall logistics of the project and transportation to project sites, and can now more accurately plan trip itineraries. The final monitoring trip will be in the spring of 2004. Project leaders anticipate that the control methods will lead to successful management of tamarisk populations in the project areas. Park staff are seeking additional funding for Phase II and Phase III of the project, and this valuable work should be continued. The EA/AEF for this project states that the park will commit to the follow up control necessary for Phase I project sites, and project leaders recommend integration of this project into the overall resource and vegetation management plans.

After completion of the final monitoring trip, project leaders should prepare articles for both internal NPS publications and peer-reviewed journals. The AWPf funding and flexibility with project implementation has been essential to getting this project off the ground, and protecting and restoring the park's valuable riparian ecosystems. The partnership between GCNP and the GCWC has also been integral to the success of the project. The primary recommendation at this point is to continue the work, and to expand the project to include all of the tamarisk populations in the side canyons and tributaries of the park.

VII. Literature Cited

- Brown, B.T., K.A. Butterfield, R.R. Johnson, and M.S. Moran. 1980. Pp. 422-432 in Proceedings of the Second Conference on Scientific Research in the National Parks, Volume 7: Ecosystem Studies. An Inventory and Classification of Surface Water Resources in Grand Canyon National Park, Arizona. USDI, National Park Service, Washington, D.C.
- Duncan, K.W. 1996. Saltcedar and Native Species in New Mexico. 1996. Presentation at Saltcedar Management and Riparian Restoration Workshop, Las Vegas, NV. September 1996.
- Johnson, R.R., C.D. Ziebell, D.R. Patton, P.F. Ffotttrott and R.H. Hamre (eds). 1985. Riparian ecosystems and their management: reconciling conflicting uses. USDA For. Serv. Gen. Tech. Rept. RM-120.
- National Park Service. 2001a. Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-Making. Washington, DC: United States Department of the Interior, National Park Service.
- National Park Service. 2001b. National Park Service Management Policies. Washington, DC: United States Department of the Interior, National Park Service.

- National Park Service. 1995a. General Management Plan, Grand Canyon National Park. Grand Canyon, AZ: United States Department of the Interior, National Park Service, Denver Service Center.
- National Park Service. 1995b. Grand Canyon National Park Strategic Plan. Grand Canyon National Park. Grand Canyon, AZ: United States Department of the Interior, National Park Service.
- National Park Service. 1985. Guide for pesticide use in the national park system. Washington, DC: United States Department of the Interior, Biological Resources Division, National Park Service.
- Phillips, B.G., R.R. Johnson, A.M. Phillips, and J.E. Bowers. 1979. Pp. 141-155 in Proceedings of the Second Conference on Scientific Research in the National Parks, Volume 4: Resource Analysis and Mapping. Resource Values of the Aquatic and Riparian Vegetation of Roaring Springs, Grand Canyon. USCA National Park Service, Washington, D.C.
- Stevens, L.E. 2001. A synthesis of information on the ecology and management of saltcedar (Tamaricaceae: *Tamarix ramosissima*), with emphasis on the Grand Canyon Region: Final Progress Report. Report Prepared for the Arizona Water Protection Fund.
- Warren, P.L., K.L. Reichhardt, D.A. Mouat, B.T. Brown, and R.R. Johnson. 1982. Technical Report Number 9 - Vegetation of Grand Canyon National Park. Prepared for National Park Service, Grand Canyon National Park. Contracts No. CX8210-7-0028 and CX8000-9-0033 Contribution No. 017/06. Cooperative National Park Resources Studies Unit, University of Arizona, Tucson, AZ.

APPENDIX A
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Photographs - 2003



Picture 1. Kim Fawcett, Kate Watters, Lori Makarick – crew leaders



Picture 2. Anne Hadley – crew leader



Picture 3. Volunteers making tool covers at Lees Ferry



Picture 4. Volunteers hauling brush at Lava Chuar



Picture 5. Tool sharpening lessons at Lees Ferry



Picture 6. Crews hauling brush

APPENDIX A
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Photographs - 2003



Picture 7. Cut stump method on mature trees



Picture 8. Sawing a mature tree



Picture 9. Crews working on tamarisk patch



Picture 10. Volunteer sawing mature tree

APPENDIX A
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Photographs - 2003



Picture 11. Vishnu crew photo



Picture 12. Volunteer cutting sapling at Hakatai



Picture 13. Volunteer using pull saw



Picture 14. Volunteers digging around mature stumps



Picture 15. Volunteers pulling seedlings at Basalt



Picture 16. Sapling and mature tamarisk at Forster

APPENDIX A
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Photographs - 2003



Picture 17. Volunteer pulling seedlings at Slimey Tick



Picture 18. Volunteer cutting mature at Galloway



Picture 19. Volunteer using pull saw at Galloway



Picture 20. Volunteers hauling brush at Bighorn wash



Picture 21. Boatman working on a sapling



Picture 22. Crews working together

APPENDIX A
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Photographs - 2003



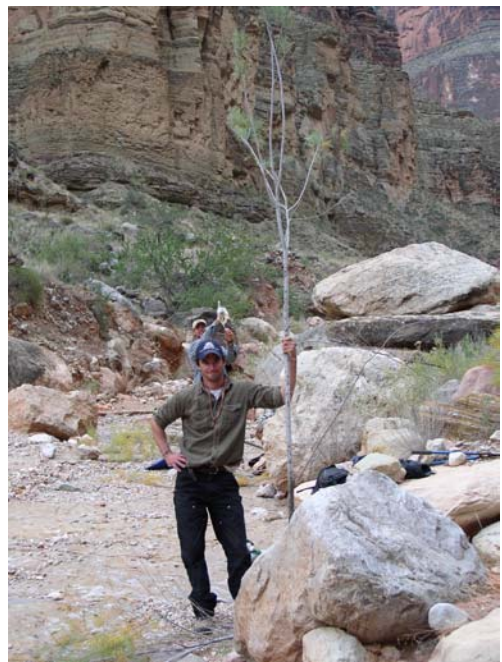
Picture 23. Angela and herbicide sprayer



Picture 24. Herbicide application



Picture 25. Seedling pulling above falls



Picture 26. Volunteer with athel (*Tamarix aphylla*) up Forster Canyon

APPENDIX B
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Documentation Photographs - 2003



94 Mile 3, pre-work, 11-3-2003



94 Mile 3, post-work, 11-3-2003



Galloway 4, view 1, pre-work, 11-9-2003



Galloway 4, view 1, post-work, 11-9-2003

APPENDIX B
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Documentation Photographs - 2003



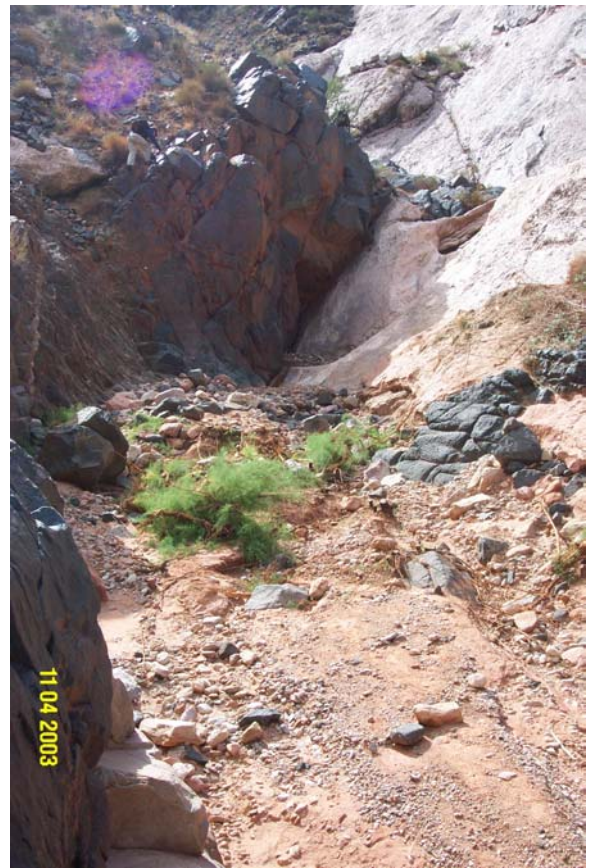
Tuna 1, pre-work, 10-14-03



Tuna 1, post-work, 10-14-03



Ruby 1 pre-work, 11-4-03



Ruby 1 post-work, 11-4-03

APPENDIX B
Tamarisk Eradication and Restoration of 63 Tributaries
Representative Project Documentation Photographs - 2003



152 Springs 1, view 1, pre-work, 11-11-03



152 Springs 1, view 1, post-work, 11-11-03



Matkatamiba 1, pre-work, 11-10-03



Matkatamiba 1, post-work, 11-10-03

Appendix C
Tamarisk Eradication and Restoration of 63 Tributaries
Photopoint Data
December 30, 2003

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Soap 1	10/13/00	1643	1	5'2"	275	28	5.6	60	infinity	0438003	4065942		H	Start point of Soap Transect #1	Endpoint of Soap transect #1
Soap 1	10/13/00	1643	2	5'2"	96	28	5.5	60	infinity	"	"		H		Down canyon toward river
Soap 1a	10/13/00	1645	1	5'2"					infinity				H		Shows start point boulder of transect #1
Soap 1b	10/13/00	1650	1	5'2"					infinity				H		Overview of Soap transect #1 - shows start point
Soap 1c	10/13/00	1655	1	5'2"					infinity	0437964	4065967		H	End point of transect #1 - from on top of gully	Overview of Soap transect
North 1	10/14/00	1145	1	5'8"	70	85	4.5	125	infinity				H	20 minutes up canyon	
North 1	10/14/00	1145	2	5'8"	236	28	8	125	infinity				H		
Tatahatso 1	10/15/00	1155	1	5'2"	305	30	8	60	infinity	0423755	4032133		H	3 satellites - 2840m elevation	
1st Redbud Alcove 1	10/15/00	1300	1	2.5'	112	45	5.6	60	infinity				H	7.5m from and parallel to uppermost tamarisk	
2nd Redbud Alcove 1	10/15/00	1400	1	5'2"	270	28	4	30	infinity				H	75m from back wall - 2 large boulders, point on alcove side of boulders	Down into alcove
2nd Redbud Alcove 1	10/15/00	1400	2	5'2"	197	28	5.6	60	infinity				H		Focus on divot in redwall across alcove
2nd Redbud Alcove 1	10/15/00	1305	3	5'2"	122	28	5.6	125	infinity				V		Toward mouth of alcove
Buckfarm 1	10/13/02	0822	1	5'2"	295	35			infinity				V	Down canyon from chockstone area with large tamarisk	Toward chockstone - still with tamarisk present
Buckfarm 1a	10/13/02	822		5'2"		35			infinity				H	Lori at photopoint	Down canyon
Buckfarm 2	10/13/02	927	1	5'2"	245	35			infinity				H	East side of drainage after you drop back into drainage from E side climb around	View of area pre-work
Buckfarm 2a	10/13/02	0930		5'2"		35			infinity				H	Lori at photopoint	Down canyon - easy spot to find
Buckfarm 3	10/13/02	1016	1	5'2"	282	35			infinity				V	Very end of canyon at large pouroff	Looking toward large pouroff and pool
Buckfarm 3a	10/13/02	1017		5'2"		35			infinity				V	Lori at photopoint	
Berts 1	10/13/02	0837	1	3'	59	35			infinity				H	100m up canyon to first big rock, standing on rock	Down canyon
Berts 1a	10/13/01	0839		5'4"	240								V	Next to sawgrass, looking up	Beginning of photopoint
Kwagunt 1	10/13/02	1500	1	5'	74	35			infinity	0425306	4012996		H	Against rock left of alluvium	Large boulder on left
Kwagunt 1a	10/13/02	1501		5'	3	35			infinity				H		View of photopoint
Malgosa 1	11/10/02	1005	1	5'	104	35			infinity	n/a			H	Midpoint above first cliff	Looking down canyon from large redwall rock

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Malgosa 1a	11/10/02	1007		5'	284	35			infinity				V		View of photopoint - looking up canyon at large limestone rock
Malgosa 2	11/10/02	1245	1	5'	208	35			infinity	0424542	4010871		V		Looking up canyon
Malgosa 2a	11/10/02	1250		5'	28	35			infinity				H		View of photopoint - looking down canyon
Carbon 1	10/16/00	1305	1	5'2"	243	28	8	60	infinity	0425665	4001132		V	Start point of Carbon transect #1	Toward endpoint of transect #1
Carbon 1	10/16/00	1305	2	5'2"	112	28	8	60	infinity	"	"		V		
Carbon 1a	10/16/00	1310	1	5'2"					infinity				H	8m down canyon from start point of Carbon transect #1	Shows start point of transect #1
Carbon 2	10/16/00	1335	1	5'2"	56	28	5.6	60	infinity	0425617	4001103		H	Endpoint of Carbon transect #1	Start point of transect #1
Carbon 3	10/16/00	1354	1	5'	77	35	11	250	infinity	0425360	4001193		H	Start point of Carbon transect #2	Endpoint of transect #2
Carbon 3	10/16/00	1354	2	5'	300	33	11	125	infinity	"	"		H		Up drainage toward North Rim
Carbon 3a	10/16/00	1354	1	5'					infinity				H		Shows start point of transect #2 (brain rock)
Carbon 4	10/16/00	1400	1	5'2"	257	50	5.6	125	infinity	0425409	4001206		H	Endpoint of Carbon transect #2	Start point of transect #2
Carbon 5	10/16/00	1430	1	5'	122	45	11	250	infinity	0425082	4001307		H	~200m up Carbon drainage from	Down canyon
Carbon 5	10/16/00	1430	2	5'	234	28	11	250	infinity	"	"		V	Carbon 3 (brain rock) , on ridge on	Up canyon
Carbon 5a	10/16/00	1430	1	5'2"					infinity				H		Rachel on Carbon 5 photopoint
Carbon 6	10/16/00	1505	1	5'2"	240	28	5.6	125	infinity	0425187	4001285		H	Start point of transect #3, read 2m on	End point of transect #3
Carbon 6	10/16/00	1504	2	5'2"	282	28	5.6	125	infinity	"	"		V	NW side of tape	Shows peak through TARA thicket
Carbon 7	10/15/02	1300	1	5'	?	35			infinity	0425362	4001190		H	From new brain rock	Down narrows
Carbon 7a	10/15/02	1300		5'					infinity					Emily at photopoint	Emily at Photopoint - note brain rock
Lava Chuar 1	10/16/00	1610	1	5'2"	308	85	5.6	250	infinity	0425279	3999819		H	Up Lava Chuar drainage from where trail drops in. Large boulder on creek right.	Overview
Lava Chuar 1	10/16/00	1610	2	5'2"	64	85	11	250	infinity	"	"		H		Shows numerous seedlings
Lava Chuar 1	10/16/00	1610	3	5'2"	107	85	8	250	infinity	"	"		H		Overview
Lava Chuar 1a	10/16/00	1610	1	5'2"					infinity				H		Lava Chuar 1 - with Fred and Chris
Lava Chuar 2	10/16/00	1635	1	5'	144	85	4.5	125	infinity	0425827	3999676		H	Start point of Lava Chuar transect #1	Endpoint of Lava Chuar transect #1
Lava Chuar 2	10/16/00	1635	2	5'	346	30	5.6	60	infinity	"	"		H		
Lava Chuar 2a	10/16/00	1645	1	5'	268				infinity				H		Lava Chuar 2 - start transect #1 with Chris and Rachel
Lava Chuar 2b	10/16/00	1645	1	5'	219				infinity				H		View of ridgeline from Lava Chuar transect #1 area
Lava Chuar 3	10/16/00	1655	1	5'	320	35	4	60	infinity	0425863	3999630		H	Endpoint of Lava Chuar transect #1	Start point of Lava Chuar transect #1
Lava Chuar 4	10/17/00	0830	1	5'	138	50	11	250	infinity	0426119	3999530		H	Start point of Lava Chuar transect #2	End point of Lava Chuar transect #1
Lava Chuar 4	10/17/00	0830	2	5'	310	85	8	250	infinity	"	"		V		Shows running water and seedlings

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Lava Chuar 4a	10/17/00	0830	1	5'	246				infinity				H		Chris at start of transect #2 - on Dox boulder in drainage
Lava Chuar 5	10/17/00	0857	1	5'4"	320	85	11	500	infinity	0426145	3999492		H	End of transect #2	Start of transect #2
Lava Chuar 6	10/17/00	0920	1	5'4"	340	85	11	250	infinity	0426133	3999545		V	From on top of Dox boulder on E. edge of drainage	Down into Lava Chuar
Lava Chuar 6	10/17/00	0920		5'4"	235	85	8	250	infinity	"	"		H		Chris at Lava Chuar 4 photopoint
Lava Chuar 6a	10/17/00	0925		5'4"	46				infinity				H		Fred standing at Lava Chuar 6 photopoint
Lava Chuar 7	10/17/00	0930	1	5'	110	28	11	125	infinity	0426300	3999481		H	Start point of transect #3	End point of transect #3
Lava Chuar 7	10/17/00	0930	2	5'	234	28	11	125	infinity	"	"		H		
Lava Chuar 7a	10/17/00	0935		5'					infinity				H		Rachel at start point of transect #3 (Lava Chuar 7)
Lava Chuar 7b	10/17/00	0935		5'					infinity				H		Chris and Rachel dropping point 2m from transect #3
Lava Chuar 8	10/17/00	1015	1	5'	284	50	11	250	infinity	0426344	3999466		H	End point of transect #3	Start point of transect #3
Lava Chuar 8	10/17/00	1015	2	5'	240	28	8	60	infinity	"	"		H		Shows dense tamarisk on edge of transect tape
Lava Chuar 9	3/11/02	1105	1	5'2"	292	35			infinity	0424769	4000013		H	About 400m up creek from the fork, near apex of rocky island below conglomerate	Up canyon
Lava Chuar 9a	3/11/02	1107		5'2"									H	Looking down canyon	Lori at the photopoint
Palisades 1	10/16/02	1028	1	5'4"	45	35			infinity	0428163	3998476		H	Standing on tapeats/BA contact	Looking down canyon - cochise butte - bearing est. NE
Palisades 1a	10/16/02	1030		5'4"	225	35			infinity				V	25m down canyon from photopoint	Looking up toward redwall - bearing estimate of SW
Palisades 2	10/16/02	1045		2'5"	45	35			infinity	0488124	3998548		H	Red boulder	Looking down canyon - temple butte
Palisades 2a	10/16/02	1041		5'5"	225	35			infinity	0428129	3998552		H	On large red boulder	Looking SW at red rock - bearing estimate of SW
Lonetree 1	10/19/00	0910	1	5'8"	32	36	5.6	60	infinity				H	~300m from river at pool just below pour off and just before steep climb	
Escalante 1	10/17/02	1400	1	5'2"	?	35			infinity				H	Right fork of canyon	Looking upstream from boulder - 2 trees up canyon
Escalante 1a	10/17/02	1400												Emily at photopoint	
75 mile 1	10/17/02	1529	1	3'5"	251	35			infinity	0420681	3988485		H	Sitting on red rock on Shinumu on E side of drainage	Looking down canyon
75 mile 1	10/17/02	1530	2	3'5"	4	35			infinity	"	"		H		Looking up canyon
75 mile 1a	10/17/02	1532		5'4"	60	35			infinity				H	Standing on debris near edge of drvfall	Shinumu ledge - Kate sitting
75 mile 1b	10/17/02	1536		5'4"	196	35			infinity				H	Standing on debris in middle of draining	Looking to east wall - Kate sitting on photopoint

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Vishnu 1	10/18/02	1400	1	5'2"	17	35				0428114	3998542		H	On schist by agave	View up canyon
Vishnu 1a	10/18/02	1400			200								H	~20m up creek of large agave - spring on creek left	View of photopoint - looking down creek
Vishnu 2	10/18/02	1440	1	2'5"	4	35			infinity	0410707	3990731		H	Standing on largest boulder	View up creek of line of TARA mixed with baccharis
Vishnu 2a	10/18/02	1423		5'3"	180	35			infinity				H	Boulder with red surface down in drainage	Looking down canyon to photopoint
Vishnu 3	10/18/02	1630	1	5'	46	35			infinity	0411109	3990979		H	Standing next to large white dike on creek right	View up creek toward rock "gate"
Vishnu 3a	10/18/02	1630		5'	281	35			infinity					Large granite boulder midcreek -	Looking down canyon to photopoint
85 mile Spring 1	10/19/00	1020	1	5'	11	28	8	125	infinity				H	Rock in middle of sandy area below spring, ~200m below Zoroaster rapid	Toward spring
85 mile Spring 1	10/19/00	1020	2	5'	118	35	11	125	infinity				H		Up river toward Zoroaster rapid
Bright Angel 1	10/20/00	0821	1	5'	286	28	5.6	60	infinity	0401594	3995355		H	Lower bridge to water treatment plant - from 5th silver post from S. side of bridge	Up Bright Angel Creek
Bright Angel 2	10/20/00	0836	1	5'	170	28	5.6	60	infinity	0401430	3995785		H	From Phantom Ranch trail crew bunkhouse, porch steps on down creek side	Down canyon
Bright Angel 3	10/20/00	0917	1	5'	198	28	8	60	infinity	0401454	3995553		H	E. side of creek - across from 2nd	
Bright Angel 3	10/20/00	0917	2	5'	166	50	5.6	125	infinity	"	"		H	campsite up from stone bathroom in	
Bright Angel 3	10/20/00	0917	3	5'	316	48	8	125	infinity	"	"		H	campground - standing on rock on W. side of trail	
Salt Creek 1	10/20/00	1410	1	5'8"	326	28	5.6	30	3m	0395047	3995125		H	300m up canyon - corners from river	
Salt Creek a	10/20/00	1410	1	5'					infinity				H		Chris at Salt Creek 1
94 mile 1	10/20/00	1540	1	5'	200	28	5.6	60	5m	0392136	3995568		H	Huge white boulder on right side of	
94 mile 1	10/20/00	1540	2	5'	351	50	5.6	60	infinity	"	"		H	drainage as walking up canyon ~350m	
94 mile 1a	10/20/00	1540	1						infinity				H		94 mile 1 photopoint
94 mile 2	10/20/00	1605	1	5'8"	326	28	5.6	60	infinity	0392207	3995976		H	760m up canyon, past cave on left, around next corner into gray/pink stretch ~30m from previous corner	
94 Mile 3	11/3/03	1235	1	5'1"	346	35				N/A	N/A		V	Above short cobbly climb, no GPS, look for spot	Up canyon
94 Mile 3a	11/3/03	1237	1	5'1"									H		Lori at 93 Mile 3 photopoint
Tuna 1	10/14/03	1020	1	4'8"	43	28-50			infinity	0386952	4000385	27	H	~30m from river, creek right, 6m up on granite dyke	Looking up creek at first tamarisk thicket
Tuna 1a	10/14/03	1029	1	5'	204	28-50			infinity	0386970	4000385		H	~38m from river from middle of drainage	Kelly at Tuna 1

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Tuna 2	10/14/03	1200	1	4'8"	10	28-50			infinity	0387255	4000469	15	H	Creek right, creek bends sharp right, up 4m on bedrock	Looking up creek at first tamarisk thicket
Tuna 2a	10/14/03	1205	1	4'8"	270	28-50			infinity	0387232	4000463		H	Creek left on chockstone grey boulder	Across the creek of Jessica at Tuna 2
Ruby 1	11/4/03	1200	1	5'	194	35			infinity	0381725	405527		V	Creek right up on schist	Looking up canyon at canyon entrance to Ruby
Ruby 1a	11/4/03	1201	1	5'	13	35			infinity				V		Kim at photopoint
Serpentine 1a	10/21/00	1041	1	5'					infinity				H		Serpentine 1 - Chris and Fred on rock SSE side of wash
Serpentine 1	10/21/00	1041	1	5'	3	28	11	125	5m	0380566	4007352		H		
Serpentine 2a	10/21/00	1107	1	5'									H		Serpentine 2
Serpentine 2	10/21/00	1107	1	5'	?	37	11	125	infinity	0380140	4007309		H	540m from beach at 2nd TARA clump	Up canyon at clump of saplings and matures
Serpentine 3a	10/21/00	1233	1	5'					infinity				H		Chris and Lori at Serpentine 3 - start of transect #1
Serpentine 3b	10/21/00	1233	1	5'					infinity				H		" - wider angle
Serpentine 3	10/21/00	1235	1	5'	248	30	11	250	infinity	0380190	4007327		H	Start of transect #1	Down transect #1
Serpentine 3	10/21/00	1235	2	5'	28	34	8	125	infinity	"	"		H		
Serpentine 4	10/21/00	1300	1	5'	76	28	5.6	60	infinity	0380146	4007312		H	End of transect #1	Start of transect #1
Serpentine 5a	10/21/00	1325	1	5'					infinity				H		Chris with board at Serpentine 5
Serpentine 5	10/21/00	1325	1	5'	314	28	8	60	3m	0380557	4007355		H	Start of transect #2	End of transect #2
Serpentine 6	10/21/00	1345	1	5'	134	40	5.6	125	infinity	0380505	4007380		H	End of transect #2	Start of transect #2
Hotauta 1	10/21/00	1551	1	5'	266	50	5.6	125	infinity	0380803	4010170		H	Up canyon at big table rock	End of transect #1
Hotauta 1a	10/21/00	1600	1	5'	72				3.5m				H		Chris and Lori at Hotauta 1 - transect #1 start point
Hotauta 2	10/21/00	1610	1	5'	94	40	3.5	30	infinity	0380752	4010167		H	End of transect #1	Start of transect #1 - Lori in photo
Hotauta 2a	10/21/00	1635	1	5'	170				infinity				V	Creek bed	Folks at Hotauta 3
Hotauta 3	10/21/00	1635	1	5'	30	28	35	30	infinity	0380186	4010199		H	Rock ledge on right as walking up canyon	Stream bed
Hakatai 1	10/14/03	1310	1	5'2"	28	35			infinity	N/A	N/A		V	1st large cobble bar above 1st waterfall - 60m from mouth	First tamarisk infestation before work
Hakatai 1a	10/14/03	1314	1	5'4"	208	35			infinity				V	Standing on cobble bar looking back at schist	View of person at photopoint
Hakatai 2	10/14/03	1400	1	5'2"	0	35			infinity	0375742	4011933	8	H	View north upstream from large boulder	Tamarisk patch
Hakatai 2a	10/14/03	1402	1	5'5"	2	35			infinity				V	View of person at photopoint	Down canyon
Hakatai 3	10/14/03	1530	1	5'2"	130	35			infinity	0375911	4012066		H	Standing on large red boulder on left side of drainage	Down canyon
Hakatai 3	10/14/03	1532	2	5'2"	300	35			infinity				H		Up canyon
Hakatai 3a	10/14/03	1538	1	5'2"	158	35			infinity				V		Person at photopoint

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Waltenberg 1	10/22/00	1040	1	5'2"	194	40	8	125	infinity				V	Start of transect #1	End of transect #1 - can see tapeats above with small TARA stand, baccharis, Aristida, Acacia
Waltenberg 1a	10/22/00	1040	1	5'2"	30	20			infinity				V	12.5m on transect #1 tape	Start point of transect #1 below dry fall
Waltenberg 2	10/22/00	1055	1	5'2"	14	28	8	125	infinity				H	End of transect #1	Start of transect #1 - shows pools
Garnet 1	11/17/02	1010	1	5'	275	70			infinity	0372289	4008469		H	Standing on schist (south) ledge of drainage - first spot after tonto trail	Looking down canyon toward river
Garnet 1	11/17/02	1010	2	5'	84	70			infinity	"	"		V		Looking up canyon with view of redwall
Garnet 1a	11/17/02								infinity	0372292	4008463		V	Standing just east of photopoint	Kate at photopoint
Garnet 2	11/17/02	1208	1	5'	330	35			infinity	0372380	4008396		V	Standing in middle of drainage on schist rock	Looking down canyon
Garnet 2a	11/17/02	1321		5'	150	35			infinity				V	From drainage	Looking up canyon at photopoint
Garnet3	3/17/2003	1341	1	5'2"	122	35			infinity	372750	4008291		V	Start of transect #1	Looking up canyon toward end of transect
Garnet 3a	3/17/2003	1343											H		Lori at start of transect #1
Garnet 3b		1345											H		Shows start of transect
Garnet 4	3/17/2003	1350	1	5'2"	302	35				372776	4009270		V	End of transect #1	Toward start of transect, large acacia to the left
Garnet 4a	3/17/2003	1400												On large boulder in creek	Lori at end of transect #1
Garnet 4b	3/17/2003	1401											V	From end of transect #1	Shows the end of the transect on the boulder
Garnet 4c	3/17/2003	1404											V		Kate on boulder (2a)
Garnet 5	3/17/2003	1406	1	5'2"					infinity				V	From 7m on the transect	Toward end of transect
Elves 1	10/22/00	1333	1	5'	260	28	8	125	2m	0369668	4006613		H	Start of transect #1 - E. side of creek	End of transect #1
Elves 1	10/22/00	1333	2	5'	222	50	8	125	infinity	"	"		H	just above 1st fall from river	Up canyon
Elves 1	10/22/00	1333	3	5'	320	30	8	125	infinity	"	"		H		Down canyon - trees are below 45,000 cfs
Elves 1a	10/22/00	1333	1	5'					infinity				H		Lori at Elves 1 - start of transect #1
Elves 2	10/22/00	1409	1	5'	80	28	11	125	5m	0369622	4006599		H	End of transect #1	Start of transect #1
Elves 3	10/22/00	1423	1	5'	33	28	8	60	3m	0369690	4006613		H		Shows TARA mixed in with baccharis, redbud and acacia
Elves 3a	10/22/00	1423	1	5'	338				infinity				H	Standing above	Lori at Elves 3
Elves 4	10/22/00	1430	1	5'	242	28	8	60	5m	0369668	4006579		H	Crack of a house-sized boulder	Scattered TARA
Elves 4	10/22/00	1430	2	5'	253	28	8	125	5m	"	"		H		Toward river
Elves 4a	10/22/00	1435	1		190				infinity				V		Lori at Elves 4 - can see 3rd waterfall in background
Bighorn Wash 1	10/22/00	1620	1	5'	224	35	5.6	60	infinity	0369014	4007125		H	Tapeats ledge W. of large pour off	Upper basin with TARA and lush riparian vegetation
Bighorn Wash 1a	10/22/00	1630	1	5'					infinity				V		Bighorn Wash 1

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Bighorn Wash 2	10/22/00	1700	1	5'	62	33	5.6	60	5m	0368902	4007036		H	Start of transect #1	End of transect #1
Bighorn Wash 2a	10/22/00	1630	1	5'	266				infinity				H		Bighorn Wash 2
Bighorn Wash 2b	10/22/00	1630	1	5'	104				infinity				H		Start of transect #1
Bighorn Wash 2c	10/22/02	1635		5'2"	243	35			infinity	0368902	4007036				View of Bighorn Wash 2 - new photo
Bighorn Wash 3	10/22/00	1730	1	5'	244	35	3.5	30	25m	0368951	4007061		H	End of transect #1	Start of transect #1 - note riparian veg and cottonwood
Lower Blacktail 1	10/23/00	1000	1	5'2"	30	85	4.5	60	4.5m				V	Start of transect #1	End of transect #1
Lower Blacktail 1	10/23/00	1000	2	5'2"	180	28	5.6	60	infinity				V		Down canyon
Lower Blacktail 1a	10/23/00	1010	1	5'2"	192				infinity				H		Rachel at start point of transect #1
Lower Blacktail 1b	10/23/00	1010	1	5'2"					infinity				H	Along transect #1	Shows TARA seedlings present
Lower Blacktail 2	10/23/00	1025	1	5'2"	210	35	4	60	infinity				V	End of transect #1	Start of transect #1
Upper Blacktail 1	11/17/02	1209	1	2'5"	299	35			infinity	0367922	4011815		H	Seep/spring in tapeats layer on R side going up canyon	Across spring seep toward blacktail canyon
Upper Blacktail 1a	11/17/02	1209		5'6"	119	35			infinity				V		Kim at photopoint
Upper Blacktail 2	11/17/02	1519	1	5'5"	345	35			infinity	0368084	4012322		H	Looking R to L heading upstream across drainage at V in tapeats	Mature and saplings across canyon
Upper Blacktail 2a	11/17/02	1520		5'5"	74	35			infinity				H		Kim at photopoint
Forster 1	10/23/00	1332	1	5'8"	252	35	8	125	infinity	0363437	4011992		H	Start of transect #1	End of transect #1
Forster 1	10/23/00	1332	2	5'8"	68	37	8	125	infinity	"	"		H		Down canyon
Forster 1	10/23/00	1332	3	5'8"		35	56	60	1m	"	"		H		Chris's feet at start point of transect #1
Forster 1a	10/23/00	1337	1	5'8"	171				infinity				H	Mid-drainage	Dave and Lori at start of transect #1
Forster 2	10/23/00	1350	1	5'8"	72	28	8	125	infinity	0363390	4011974		H	End of transect #1	Start of transect #1
Forster 3	10/23/00	1403	1	5'	20	28	11	125	3m	0363340	4011389		H	E. side of bend in creekbed - near small seep 410m from river	
Forster 3	10/23/00	1404	2	5'	328	28	11	125	3m	"	"		H		
Forster 3a	10/23/00	1420	1	5'					infinity				H		Forster 3 with Fred
Specter 1	10/24/00	1040	1	5'2"	322	28	11	125	1.5m	0366731	4020182		H	Start of transect #1	End of transect #1
Specter 1	10/24/00	1040	2	5'2"	222	28	11	125	infinity	"	"		H		Toward wash with TARA opposite transect #1
Specter 1a	10/24/00	1050	1	5'2"	16				infinity				H	Wash below transect	Specter 1 - transect #1 start point with Chris and Tim
Specter 2	10/24/00	1100	1	5'2"	148	28	11	250	2m	0366700	4020224		V	End of transect #1	Start of transect #1
Specter 1b	10/24/00	1105	1	5'2"					infinity				V		TARA washed over
Specter 3	10/24/00	1120	1	5'2"	267	28	8	125	3m	0366757	4020184		H	Start of transect #2	End of transect #2
Specter 3a	10/24/00	1130	1	5'2"					infinity				H		Rachel at start of transect #2
Specter 4	10/24/00	1149	1	5'2"	95	28	11	125	2.5m	0366699	4020170		H	End of transect #2	Start of transect #2
Specter 5	10/24/00	1149	1	5'2"	106	85	5.6	125	infinity	0367243	4019773		H		Toward river
Specter 5a	10/24/00	1200	1	5'	332				infinity				H		Lori at Specter 5

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Galloway 1	10/15/03	1555	1	5'2"	46	35			infinity	N/A	N/A		H	From creek left, about 15m up canyon from where trail from Galloway camp drops into drainage	View up canyon - first clump of trees
Galloway 1a	10/15/03	1557	1	5'2"		35			infinity				H	Standing in drainage	Red jug at the photopoint
Galloway 2	10/15/03	1608	1	5'2"	292	35			infinity	0369981	4022771		V	First bass limestone outcrop walking up from the river	Looking down creek at large bass boulder
Galloway 2a	10/15/03	1616	1	5'2"	352	35			infinity				H		Person at photopoint, looking across drainage at first bass limestone outcrop
Galloway 3	10/15/03	1715	1	5'2"	223	35			infinity	0370289	4022664		H	On large boulder in center of drainage	Down canyon view
Galloway 3	10/15/03	1716	2	5'2"	32	35			infinity				H	(in hakatai shale above waterfall)	Up canyon view
Galloway 3a	10/15/03	1718	1	5'2"	43	35			infinity				V		Person at photopoint
Galloway 4	11/9/03	0854	1	5'2"	240	Wide			infinity	0370364	4022692	10	H	Big orange/purple rock	Down canyon
Galloway 4	11/9/03	0859	2	5'2"	16	Wide			infinity				H		Up canyon
Galloway 4a	11/9/03	0900	1	5'2"	269	Wide			infinity				H		Person at Galloway 4 photopoint
Galloway 5	11/9/03	1430	1	5'2"	119	Wide			infinity	0370768	4022804	8	H		Up canyon looking at shinumu overhang
Galloway 5a	11/9/03	1433	1	5'2"	300	Wide			infinity				H	Under big shinumu boulder on creek right	Person at photopoint
Cranberry 1	10/25/00	1315	1	5'2"	10	28	11	250	infinity	0361693	4029519		H	Start of transect #1	End of transect #1
Cranberry 1	10/25/00	1315	2	5'2"	357	28	11	125	infinity	"	"		V		Up canyon - shows cottonwoods
Cranberry 1	10/25/00	1315	3	5'2"	214	28	11	125	infinity				V		Down canyon - shows next layer below tapeats
Cranberry 1a	10/25/00	1310	1	5'2"					infinity				H	11.5m from transect #1 start	Dave at Cranberry 1
Fishtail 1	11/20/02	1020	1	5'5"	19	35			infinity				H	Standing on large rock in rockfall	View of TARA grove
Fishtail 1a	11/20/02	1020		5'5"	270	35			infinity				V		Kim in rockfall with camera
142 mile spring 1	10/24/02	1106	1	5'2"	16	35			infinity	0356703	4029027		H	From beach	Spring and veg below
142 mile spring 1	10/24/02	1106	2	5'2"	112	35			infinity				H		Upriver
142 mile spring 1a	10/24/02	1108		5'2"		35			infinity				H	From beach	Lori at photopoint - looking up river
148 Mile Spring 1	11/19/02	1130	1	5'	19	35			infinity				V	Big limestone rock just downstream of spring	Looking upstream at mature TARA in seep
148 Mile Spring 2	11/19/02	1145	1	5'	100	35			infinity				H	From behind spring on muav shelf	Looking into spring
148 Mile Spring 2a	11/19/02	1148		5'	280	35			infinity				V		Kate on Muav shelf photopoint
Ledges 1	10/26/00	1119	1	5'2"	241	28	45	60	infinity				H	2nd ledge layer	Shows lower vegetation - diverse with some TARA
Ledges 1a	10/26/00	1115	1	5'8"	290				infinity				H		Lori at Ledges 1

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Ledges 2	10/26/00	1135	1	5'	162	85	45	125	infinity				H		TARA in pools with riparian vegetation
Ledges 2	10/26/00	1135	2	5'	302	28	45	250	infinity				V		Upper spring - no TARA
Ledges 2a	10/26/00	1140	1	5'	300				infinity				V		Chris at Ledges 2
Matkat 1	11/10/03	1345	1	6'	296	35			infinity				V	~250m above main amphitheater standing on temple butte boulder	View of TARA down canyon on creek right
Matkat 1a	11/10/03	1346	1	5'	96	35			infinity				H	Standing in drainage	Kim at Matkat 1 photopoint
152 Spring 1	11/11/03	1015	1	5'2"	109	Wide			infinity	0345172	4023229	12	H		View of lower ledge
152 Spring 1	11/11/03	1020	2	5'2"	110	Wide			infinity				H		View of middle ledge
152 Spring 1a	11/11/03	1022	1	5'2"	115	Wide			infinity				H		Kate at photopoint
Slimey Tick 1	10/26/00	1330	1	5'2"	300	40	11	250	infinity	0342562	4021270		H	Before final drop down into the canyon	Some TARA mixed in with cattails, willows and grasses
Slimey Tick 1	10/26/00	1330	2	5'2"	220	28	11	125	infinity	"	"		H		Lower pool above steep Muav drop off above river - no TARA
Slimey Tick 1a	10/26/00	1335	1	5'2"					infinity				H		Chris at Slimey Tick 1
Slimey Tick 2	10/26/00	1345	1	5'2"	342	28	11	125	2m	0342533	4021296		V	Muav ledge below stairstep falls	Shows ash, monkey flowers, phragmites, cattails up canyon
Slimey Tick 2	10/26/00	1345	2	5'2"	155	28	11	125	2m	"	"		H		Down canyon
Slimey Tick 2a	10/26/00	1350	1	5'2"	170				infinity				H		Chris at Slimey Tick 2
Last Chance 1	10/26/00	1530	1	5'8"	82	28	5.6	60	4m	0342146	4020880		H	Muav slab ~8m from dripping spring start of transect #1	End of transect #1
Last Chance 1	10/26/00	1530	2	5'8"	36	32	5.6	60	infinity				H		Up river toward Zoroaster rapid
Last Chance 1	10/26/00	1530	3	5'8"	152	84	5.6	125	infinity				H		Down river
Last Chance 1a	10/26/00	1545	1	5'8"					infinity				H		Chris and Lori at Last Chance 1
Last Chance 2	10/26/00	1558	1	5'8"	264	28	5.6	60	1.4m	0342172	4020889		H	25m on transect tape - 45,000 cfs	Start of transect #1
Last Chance 2a	10/26/00	1600	1	5'8"					infinity				V		Chris at Last Chance 2
Last Chance 3	10/26/00	1602	1	5'8"	320	28	4.5	125	infinity	0342176	4020878		H	Sand 4m from drainage	Shows TARA at spring with Lori
Stairway 1	11/21/02	1443	1	5'	48	35			infinity	0323699	4012003		V	On R side of drainage in Muav	Looking up canyon
Stairway 1a - missing															
Stairway 2	11/21/02	1500	1	5'	12	35			infinity	0323743	4012056		H	L side of drainage on rock	Up canyon
Stairway 2a	11/21/02	1505		5'	194	35			infinity				V	Left side of drainage on rock	Person at photopoint
Cove 1	10/28/00	1020	1	5'2"	196	28	5.6	60	1.75m				V	Start of transect #1 - large boulder clump ~100m below pour off at end of lower Cove	End of transect #1
Cove 1	10/28/00	1020	2	5'2"	285	28	5.6	60	2.5m				H		
Cove 1	10/28/00	1020	3	5'2"	144	28	5.6	60	2m				H		
Cove 1a	10/28/00	1030	1	5'2"	68				infinity				H		Chris and Rachel at Cove 1
Cove 2	10/28/00	1040	1	5'2"	196	30	8	60	2.5m				H	30m along transect tape	End of transect #1
Cove 2	10/28/00	1040	2	5'2"	267	28	8	60	2.5m				H		Toward wall

Photopoint Name	Date	Time	View #	Camera Height	Compass Bearing	Lens Size	F-Stop	Speed	Focus Distance	Northing	Easting	GPS Accuracy (m)	Vertical / Horizontal	Photopoint Description / Comments	View From Photopoint
Cove 2	10/28/00	1040	3	5'2"	98	28	8	60	1.5m				H		Dense TARA
Cove 3	10/28/00	1045	1	5'8"	8	28	8	60	3m				H	Start of transect #2 - large boulder	End of transect #2
Cove 3	10/28/00	1045	2	5'8"	292	28	8	60	3m				H	mid-drainage ~100m from transect #1	
Cove 3a	10/28/00	1045	1	5'8"					infinity				H		Rachel and Roy at Cove 3 - start of transect #2
Cove 4	10/28/00	1100	1	5'8"					infinity				H	35m on transect	End of transect #2
Cove 5	10/28/00	1105	1	5'8"	188	28	8	60	3m				H	End of transect #2	Start of transect #2
Cove 5	10/28/00	1105	2	5'8"	226	28	8	125	3m				H		
Cove 6	10/28/00	1110	1	5'8"	321	28	8	125	5m				H	NE side of drainage where there is a	
Cove 6	10/28/00	1110	2	5'8"	292	28	8	60	4m				H	small drainage entering with pour over	
Cove 6	10/28/00	1110	3	5'8"	228	28	8	60	5m				H		
Cove 6a	10/28/00	1120	1	5'2"	60				infinity				V		Chris at Cove 6
Cove 7	10/28/00	1127	1	5'	180	28	11	125	2m				H	mid-drainage rock	
Cove 7a	10/28/00	1130	1	5'					infinity				H		Lori and Chris at Cove 7
Upper Cove 1	11/22/02	0955	1	2'5"	338	35			infinity	0318942	4012760		H	Standing on white rock on R side or drainage	View of TARA grove
Upper Cove 1a	11/22/02	0955		6'					infinity				H		View of Kim standing at photopoint
214 Mile 1	11/14/03	1050	1	5'4"	250	Wide			infinity	0289795	3995353	80	H	(Note-The easting 3rd digit might be a 7 - hard to read)	Up canyon
214 mile 1a	10/14/03	1052	1	5'7"	120	Wide			infinity				V		Angela at photopoint

*NOTE - Creak left/right is as you are walking down the drainage - NOT UP!

*NOTE - The photopoint names that include a "letter" depict photographs used for transect or photopoint relocation; they are general photographs and not intended to be photopoints.

Appendix D
Tamarisk Eradication and Restoration of 63 Tributaries
October 2003 Volunteer and Matching Hours

	10/1	10/2	10/3	10/4	10/5	10/6	10/7	10/8	10/9	10/10	10/11	10/12	10/13	10/15	10/15	10/16	10/17	10/18	10/19	10/20	10/21	Total
Alison Steen	4.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	8.0										119
Anne Hadley												12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		100
Chris Louderback	4.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	8.0										119
Dave Gentempo		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	8.0										115
Heather Millar		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	12.0	11.0	8.0										117
Herman Griego		13.0										12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		113
Jeri Ledbetter	10.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	12.0	6.0	12.0	11.5	13.0	12.0	8.0	10.0	11.0	10.0	10.0	6.0	217
Jessica Cortwright	5.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		211
Johanna Divine		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	8.0										115
John Sterling												12.0	11.5	13.0	12.0	8.0	10.0	11.0	10.0	10.0		98
Kate Thompson												12.0	11.5	13.0	12.0	8.0	10.0	11.0	10.0	10.0		98
Kate Watters	4.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		210
Kelly Burke	4.0	13.0										12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		117
Kelly Watters		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	8.0										115
Kim Crumbo	0.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		206
Kim Fawcett	10.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		216
Larry Stevens	0.0	0.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	12.0	10.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		197
Lori Makarick	10.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		216
Margie Erhart												12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		100
Matt Dunn		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	6.0	12.0	11.5	13.0	12.0	8.0	10.0	11.0	10.0	10.0	6.0	205
Scott Smith		10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	8.0	10.0	11.0	10.0	10.0		204
Simone Sellin	10.0	10.0	9.0	13.0	9.0	12.5	12.0	10.0	10.0	10.0	11.0	12.0	11.5	13.0	12.0	10.0	10.0	11.0	10.0	10.0		216

NPS matching hours	216	PAID hours	1582.5	Total Hours	3418
NO FILL - Volunteer Hours	1620			Total Volunteer Hours	1620
				Total Paid Hours	1583
				Total NPS Hours	216
				Total Project Hours	3418

Appendix D
Tamarisk Eradication and Restoration of 63 Tributaries
November 2003 Volunteer and Matching Hours

	10/26	10/27	10/28	10/29	10/30	10/31	11/1	11/2	11/3	11/4	11/5	11/6	11/7	11/8	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/17	Total
Alison Steen	4	0	10	10	10	10	10	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	190
Angela Sokolowski	0	0	0	0	0	0	7	11	10	9	11	10	10	11	10	11	10	11	10	10	9	0	150
Beach Huntsman	0	0	0	0	0	0	7	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	143
Chad Olson	0	0	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Chris Louderback	4	0	10	10	10	10	10	10	10	9	11	11	10	9	8	10	10	10	10	10	9	0	191
Chris Moore	0	0	0	0	8	8	7	10	10	9	11	11	10	9	8	10	10	10	10	10	9	10	170
Dan Hall	4	0	10	10	10	10	10	10	10	9	11	8	10	9	8	10	10	10	10	10	9	0	188
Dave Gentempo	0	0	0	0	0	0	7	10	10	9	11	11	10	9	8	10	10	10	10	10	9	0	144
Jessica Cortwright	0	0	0	0	0	0	7	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	143
Kate Watters	4	8	0	0	0	0	10	11	10	9	11	12	10	11	10	11	10	11	10	10	9	0	167
Kim Fawcett	10	8	0	0	0	0	10	11	10	9	11	10	10	11	10	11	10	11	10	10	9	8	179
Lori Makarick	10	0	0	0	0	0	10	11	10	9	11	11	10	11	10	11	10	11	10	10	9	8	172
Michael Whalen	0	0	10	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	2	0	62
Nicole Corbo	0	0	10	10	10	10	10	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	186
Rachel Schmidt	0	0	0	0	0	0	8	10	10	9	11	11	10	9	8	10	10	10	10	10	9	0	145
Simone Sellin	10	8	0	0	0	0	10	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	164
Steven Till	0	0	0	0	0	0	7	10	10	9	11	10	10	9	8	10	10	10	10	10	9	0	143
Willow Nelson	0	0	0	0	0	0	7	10	10	9	11	11	10	9	8	10	10	10	10	10	9	0	144

NPS matching hours 190

PAID hours 1582

NO FILL - Volunteer Hours 959

Total Hours 2731
Total Volunteer Hours 959
Total Paid Hours 1582
Total NPS Hours 190

Total Project Hours 2731